UNITED
NATIONS

A

General Assembly

Distr.
GENERAL

A/AC.105/456
12 March 1990

ORIGINAL: ENGLISH

COMMITTEE ON THE PEACEFUL USES
OF OUTER SPACE

# REPORT OF THE SCIENTIFIC AND TECHNICAL SUB-COMMITTEE ON THE WORK OF ITS TWENTY-SEVENTH SESSION

## INTRODUCTION

1. The Scientific and Technical Sub-Committee of the Committee on the Peaceful Uses of Outer Space held its twenty-seventh session at United Nations Headquarters from 26 February to 9 March 1990 under the chairmanship of Professor J. H. Carver (Australia).

2. Representatives of the following Member States attended the session: Argentina, Australia, Austria, Belgium, Benin, Brazil, Bulgaria, Burkina Faso, Canada, Chile, China, Colombia, Czechoslovakia, Ecuador, Egypt, France, German Democratic Republic, Germany, Federal Republic of, Hungary, India, Indonesia, Iran (Islamic Republic of), Iraq, Italy, Japan, Lebanon, Mexico, Mongolia, Morocco, Netherlands, Nigeria, Pakistan, Philippines, Poland, Portugal, Romania, Sweden, Syrian Arab Republic, Turkey, Union of Soviet Socialist Republics, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay, Venezuela, Viet Nam and Yugoslavia.

3. Representatives of the Department of Technical Co-operation for Development of the United Nations Secretariat, the United Nations Environment Programme (UNEP), the Office of the United Nations Disaster Relief Co-ordinator (UNDRO) and the Centre for Science and Technology for Development also attended the session.

4. Representatives of the following specialized agencies attended the session: Food and Agriculture Organization of the United Nations (FAO), International Telecommunication Union (ITU), World Health Organization (WHO), World Meteorological Organization (WMO), International Atomic Energy Agency (IAEA) and United Nations Educational, Scientific and Cultural Organization (UNESCO).

5. Representatives of the European Space Agency (ESA), the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU), the International Astronautical Federation (IAF), the International Organization for



best copy available

Space Communications (INTERSPUTNIK), the International Telecommunications Satellite Organization (INTELSAT) and the Council on International Co-operation in the Study and Utilization of Outer Space (INTERCOSMOS) also attended the session.

6. A list of the representatives of Member States, specialized agencies and other international organizations attending the session is contained in document A/AC.105/C.1/INF/19.

7. At the opening of the session, the Sub-Committee adopted the following agenda:

1. Adoption of the agenda.

2. Statement by the Chairman.

3. General exchange of views.

4. United Nations Programme on Space Applications and the co-ordination of space activities within the United Nations system.

5. Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space.

6. Matters relating to remote sensing of the Earth by satellites, including, inter alia, applications for developing countries.

7. Use of nuclear power sources in outer space.

8. Questions relating to space transportation systems and their implications for future activities in space.

9. Examination of the physical nature and technical attributes of the geostationary orbit; examination of its utilization and applications, including, inter alia, in the field of space communications, as well as other questions relating to space communications developments, taking particular account of the needs and interests of developing countries.

10. Matters relating to life sciences, including space medicine.

11. Progress in the geosphere-biosphere (global change) programme.

12. Matters relating to planetary exploration.

13. Matters relating to astronomy.

14. The theme fixed for special attention at the 1990 session of the Scientific and Technical Sub-Committee: "The use of space technology in terrestrial search and rescue and in disaster relief activities."

15. Other matters.

16. Report to the Committee on the Peaceful Uses of Outer Space.

## Meetings and documentation

8. The Sub-Committee held 15 meetings.

9. A list of the documents which were before the Sub-Committee is provided in annex I to the present report.

10. At the opening meeting, the Chairman made a statement outlining the work of the Sub-Committee at its current session. He also reviewed the activities of Member States in the field of space exploration, including important advances that had been achieved as a result of international co-operation during the past year.

11. At the 371st, 373rd and 374th meetings, the Chairman informed the Sub-Committee that requests had been received from the permanent representatives of Bolivia, Costa Rica, Greece, Spain, Cuba and Malaysia, as well as from the Permanent Observer for the Holy See, to attend the session. Following past practice, those delegations were invited to attend the current session of the Sub-Committee and to address it as appropriate. This was without prejudice to further requests of that nature and did not involve any decision of the Sub-Committee concerning status, but was a courtesy that the Sub-Committee extended to those delegations.

12. General statements were made by the following delegations: Austria, Brazil, China, Czechoslovakia, German Democratic Republic, Germany, Federal Republic of, India, Indonesia, Iraq, Japan, Pakistan, USSR, United States, as well as by Costa Rica. Statements were also made by the representatives of FAO, ITU, COSPAR, IAF, INTERSPUTNIK, INTELSAT and INTERCOSMOS.

13. At the 371st meeting, the Chief of the Outer Space Affairs Division made a statement reviewing the work programme of the Outer Space Affairs Division. At the 372nd meeting, he made a statement concerning the programme budget for the biennium 1990-1991, which had been approved by the General Assembly at its forty-fourth session, and the medium-term plan for the period 1992-1997, which would be presented to the General Assembly at its forty-fifth session. At the 373rd meeting, the Expert on Space Applications made a statement outlining the activities carried out and planned under the United Nations Programme on Space Applications. At the 379th meeting, the Under-Secretary-General for Political and Security Council Affairs and the Executive Director of the Centre for Science and Technology for Development made statements to the Sub-Committee concerning the proposed activities of the Centre relating to outer space and the arrangements for co-operation between the Centre and the Outer Space Affairs Division in these activities (see para. 41).

## Technical presentations

14. In accordance with paragraph 8 (b) (vii) of General Assembly resolution 44/46 of 8 December 1989, a symposium on the theme "The use of space technology in terrestrial search and rescue and in disaster relief activities", sponsored by IAF and COSPAR, was held in two sessions. The first session of the symposium was

introduced by the Vice-President of IAF, Mr. James Harford, and chaired by Mr. Burton Edelson, Co-Chairman of the IAF Committee for the International Space Year. It included an overview by Mr. Louis Walter of the United States National Aeronautics and Space Administration (NASA); and presentations by Mr. Wilbur Pritchard of W. L. Pritchard and Co., United States, on "Communications during Disasters"; and Mr. Ted Engman of the United States Department of Agriculture, on "Severe Floods", co-authored with Mr. A. Rango. The second session was introduced by Mr. A. J. Somogyi of COSPAR and chaired by Mr. George Ohring, Chairman of the COSPAR Commission on Space Studies of Earth's Surface, Meteorology and Climate. It included presentations by Mr. Louis Walter of NASA on droughts, Mr. Shui-shang Chi of the State University of New York at Buffalo, United States, on "Severe Storms", co-authored with Mr. George C. Lee and Mr. Ching-yen Tsay; Mr. James T. Bailey of the United States National Oceanic and Atmospheric Administration (NOAA), on "Search and Rescue", and Mr. Valery Bogdanov of the USSR V/O Morsviazsputnik on "COSPAS-SARSAT: Status and Future Developments". In accordance with paragraph 7 (b) (iv) of General Assembly resolution 43/56 of 6 December 1988, COSPAR arranged a special presentation on progress in the International Geosphere-Biosphere (Global Change) Programme. The presentation was made by Dr. S. Ichtiaque Rasool of NASA.

15. During the session of the Sub-Committee, in addition to the COSPAR/IAF symposium, special scientific and technical presentations were made by Dr. M. G. Chandrasekhar of the Indian Space Research Organization, on the use of space technology for terrestrial search and rescue and disaster mitigation and on India's geosphere-biosphere research; by Mr. Donald Hinsman of WMO, on WMO's participation in the International Decade for Natural Disaster Reduction; by Dr. Walter Göbel of the Space Research Institute of the Federal Republic of Germany, on a distress alert system using the Inmarsat satellites; by Mr. Frank Owens and Ms. Elaine Schwartz of NASA, on NASA's educational programmes; by the United States astronaut, Mr. Ron Grabe, on his recent Space Shuttle mission that had launched the Magellan spacecraft; by Dr. Alan Bunner of NASA, on NASA's space-based astronomy programmes; by Dr. Gordon Pettengill of the Massachusetts Institute of Technology, United States, on the Magellan Venus radar mapping mission; by Dr. Marianne von Glehn of the Swedish National Space Board, on the Swedish remote sensing programme; by Dr. Krishna Rao of NOAA, on remote sensing; by Mr. Shabir Ahmed of the Canadian Space Agency, on the Radarsat project; by Dr. Stan Wilson of NASA, on ocean remote sensing and the United States Earth Observing System (EOS); and by Mr. Yuri Grigoriev of the USSR, on the international Priroda-Almaz programme.

## Recommendations of the Scientific and Technical Sub-Committee

16. After considering the various items before it, the Sub-Committee, at its 385th meeting, on 9 March 1990, adopted its report to the Committee on the Peaceful Uses of Outer Space containing its views and recommendations as set out in the paragraphs below.

I. UNITED NATIONS PROGRAMME ON SPACE APPLICATIONS AND THE CO-ORDINATION OF SPACE ACTIVITIES WITHIN THE UNITED NATIONS SYSTEM

II. IMPLEMENTATION OF THE RECOMMENDATIONS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

17. The Sub-Committee conducted a joint consideration of the items "United Nations Programme on Space Applications and the co-ordination of space activities within the United Nations system" and "Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space".

18. The Sub-Committee noted that the General Assembly, in paragraph 14 of resolution 44/46, had once again emphasized the urgency and importance of implementing fully the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) as early as possible. The Sub-Committee also took note of paragraph 9 of the same resolution, whereby the General Assembly stated that, in the context of the Sub-Committee's consideration of the item, it was particularly urgent to implement the following recommendations:

"(a) All countries should have the opportunity to use the techniques resulting from medical studies in space;

"(b) Data banks at the national and regional levels should be strengthened and expanded and an international space information service should be established to function as a centre of co-ordination;

"(c) The United Nations should support the creation of adequate training centres at the regional level, linked, whenever possible, to institutions implementing space programmes; necessary funding for the development of such centres should be made available through financial institutions;

"(d) The United Nations should organize a fellowship programme through which selected graduates or post-graduates from developing countries should get in-depth, long-term exposure to space technology or applications; it is also desirable to encourage the availability of opportunities for such exposures on other bilateral and multilateral bases outside the United Nations system."

19. In response to the recommendations of the Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space contained in its report on the work of its third session held in 1989 (A/AC.105/429, annex II, paras. 4, 5 and 6), endorsed by the General Assembly in paragraph 11 of resolution 44/46, the Sub-Committee had before it a number of reports: a report on international co-operation in the peaceful uses of outer space - programmes of Member States (A/AC.105/448 and Add.1-3), in response to paragraphs 4 (c) and 5 (a) of the report of the Working Group; a report on international co-operation in

the peaceful uses of outer space - programmes of international space organizations (A/AC.105/449), in response to paragraph 4 (d); a report on regional and international education, training and research centres in space science and technology and its applications (A/AC.105/450), in reponse to paragraph 5 (b); a report on implementation of the recommendations of the UNISPACE 82 conference (A/AC.105/451), in response to paragraph 6; and a report on United Nations activities related to space applications (A/AC.105/454), in response to paragraphs 4 (a), (e), (f), (j), (k) and 5 (c), (d).

20. In accordance with paragraph 10 of General Assembly resolution 44/46, the Sub-Committee reconvened the Working Group of the Whole with a view to improving the execution of activities relating to international co-operation, particularly those included in the United Nations Programme on Space Applications, and to propose concrete steps to increase such co-operation as well as to make it more efficient. The Working Group of the Whole was chaired by Mr. Raimundo González (Chile); it held 7 meetings between 27 February and 6 March 1990 and adopted its report (A/AC.105/C.1/WG.6/L.167) on 6 March 1990.

21. Having considered the report of the Working Group of the Whole, the Sub-Committee decided at its 384th meeting, on 8 March 1990, to adopt that report, as contained in annex II to the present report, on the understanding that the recommendations contained therein would be carried out in accordance with paragraph 9 of General Assembly resolution 37/90 of 10 December 1982. The Sub-Committee recommended that the Working Group of the Whole be reconvened the next year to continue its work.

## A. United Nations Programme on Space Applications

22. Regarding the expanded United Nations Programme on Space Applications, the Sub-Committee had before it the report of the United Nations Expert on Space Applications (A/AC.105/446). The report was supplemented by the statement by the Expert. The Sub-Committee noted that the Programme on Space Applications for 1989 had been carried out satisfactorily and commended the work accomplished by the Expert in carrying out his work programme as endorsed by the Sub-Committee at its last session.

23. The Sub-Committee noted with appreciation that since its last session, additional contributions had been offered by various Member States and organizations and that they had been acknowledged with appreciation in paragraph 45 of the Expert's report, as well as under appropriate sections of the current report.

24. In this connection, the Sub-Committee continued to express its concern over the meagre financial resources available for carrying out the Programme and appealed to Member States to support the Programme through voluntary contributions. The Sub-Committee felt that the limited resources of the United Nations should be focused on the highest priority activities and noted that the Programme on Space Applications was the priority activity of the Outer Space Affairs Division.

1. 1989-1990

(a) Long-range fellowships for in-depth training

25. The Sub-Committee expressed its appreciation to the Governments of Austria, Brazil, the German Democratic Republic and the USSR as well as to ESA for having offered the training fellowships for the period 1989-1990 that were currently being conducted, as shown in annex II to the Expert's report (A/AC.105/446). The Sub-Committee noted with appreciation that the offers of fellowships were expected to be continued for 1990-1991 by the same Governments and organization as indicated by the Expert in his statement. The Sub-Committee also noted that the Government of the USSR had established six new three-year fellowships for interns and post-graduates from developing countries, as indicated in paragraph 8 of the Expert's report, and that the Government of China had offered three fellowships in the fields of geodesy, cartography and remote sensing.

26. The Sub-Committee noted that it was important to increase the opportunities for in-depth education in all areas of space science, technology and applications through long-term fellowships.

(b) Technical advisory services

27. The Sub-Committee took note of the technical advisory services provided by the Outer Space Affairs Division in support of regional space applications projects. It noted that, as a follow-up to the United Nations/United Nations Development Programme (UNDP)/FAO/ESA Meeting of Experts on Remote Sensing and Satellite Meteorology Applications to Marine Resources and Coastal Management (see A/AC.105/436), a mission would be undertaken with UNDP funding to develop a regional programme for the Atlantic Coast of Africa region focusing on remote-sensing data acquisition, processing and dissemination to complement the conventional means already in use in each country for oceanographic and marine applications and to expand and enhance training capabilities in remote sensing, particularly in marine sciences.

28. The Sub-Committee noted that technical advisory services were also provided to the Secretariat of the Indian Ocean Marine Affairs Co-operation (IOMAC) Programme for the planning of remote-sensing pilot projects to be carried out with financial support from UNDP in order to study the feasibility of using satellite remote sensing for mapping, monitoring and managing the coastal and marine resources in the region. The Sub-Committee noted the offer of the Government of France to provide assistance to the project in co-operation with the United Nations.

29. The Sub-Committee also noted the assistance provided by the Outer Space Affairs Division to the Ministry of Science and Technology of the Government of Costa Rica in the organization of the "Space Conference of the Americas: Prospects of Co-operation for Development", to be sponsored by the Government of Costa Rica with the support of UNDP and held at San José from 12 to 16 March 1990.

(c) United Nations workshops/training courses/seminars/meetings of experts

30. With regard to the activities of the Programme carried out in 1989, the Sub-Committee expressed its appreciation to: (a) the Government of Spain as well as UNDP, FAO and ESA, for co-sponsoring the United Nations/UNDP/FAO/ESA Meeting of Experts on Remote Sensing and Satellite Meteorology Applications to Marine Resources Coastal Management, hosted by the Instituto Nacional de Técnica Aerospacial and held at Maspalomas, Canary Islands, from 8 to 12 May 1989 (see A/AC.105/436); (b) to the Government of Australia as well as the Economic and Social Commission for Asia and the Pacific (ESCAP), FAO, WMO and ESA, for co-sponsoring the Fifth United Nations/FAO/WMO/ESA International Training Course on the Use of Remote Sensor Systems in Agrometeorological and Hydrological Applications, hosted by the Office for Space Science Applications of the Commonwealth Scientific and Industrial Research Organization and the Australian Centre for Remote Sensing and held at Canberra from 15 May to 2 June 1989 (see A/AC.105/437); (c) the Government of the United Kingdom, for co-sponsoring the United Nations International Meeting of Experts on the Development of Remote Sensing Skills and Knowledge, hosted by the University of Dundee and held at Dundee from 26 to 30 June 1989 (see A/AC.105/438); (d) the Government of Pakistan as well as IOMAC, for co-sponsoring the United Nations/IOMAC Workshop on Oceanographic/Marine Space Information Systems, hosted by the Pakistan Space and Upper Atmosphere Research Commission and held at Karachi from 2 to 6 July 1989 (see A/AC.105/439); (e) the Government of the USSR, for co-sponsoring the United Nations International Training Course on the Use of Remote Sensing Data in Agricultural Management, hosted by the USSR State Committee for Science and Technology and the Scientific Research Centre "AIUS-Agroresources" and held in Moscow from 25 September to 6 October 1989 (see A/AC.105/440); (f) the Government of the German Democratic Republic, for co-sponsoring the Second United Nations International Training Course on Remote Sensing Applications to Geological Sciences, hosted by the Academy of Sciences and held at Potsdam from 5 to 22 October 1989 (see A/AC.105/441); and (g) the Government of Italy as well as FAO for co-sponsoring the Fourteenth United Nations/FAO International Training Course on the Applications of Remote Sensing to Land Resources, held at FAO headquarters in Rome from 6 to 24 November 1989 (see A/AC.105/442).

31. The Sub-Committee took note of the status of the 1990 programme of United Nations workshops/training courses/seminars/meetings of experts, which included the following activities, as described in paragraphs 31 (a) to (e) of the Expert's report (A/AC.105/446):

(a) United Nations Workshop on Space Communication for Development: Current and Future Developments, Rural Communications, Search and Rescue Missions and Disaster Relief, to be organized in co-operation with the Government of Cuba for the benefit of Member States in the region of the Economic Commission for Latin America and the Caribbean (ECLAC) and held at Havana from 26 to 30 March 1990;

(b) Fifteenth United Nations/FAO International Training Course on Remote Sensing Applications to Renewable Resources, to be organized in co-operation with the Government of Italy and hosted by FAO in Rome;

(c) First United Nations Training Course on Remote Sensing Education for Educators, to be organized in co-operation with the Government of Sweden for the benefit of Member States in the region of the Economic Commission for Africa (ECA) and hosted by the Swedish Agency for International Technical and Economic Co-operation at Stockholm and Kiruna from 14 May to 15 June 1990;

(d) United Nations Workshop on Basic Space Research for the benefit of developing countries, in September/October 1990;

(e) Second United Nations/FAO/ESA Workshop on Microwave Remote Sensing Technology, to be organized in co-operation with the Government of Brazil for the benefit of Member States in the ECLAC region and hosted by the Instituto de Pesquisas Espaciais (INPE) at São José dos Campos from 9 to 14 September 1990.

32. The Sub-Committee also noted that two additional activities would be included in the 1990 programme:

(a) United Nations/FAO/ESA International Workshop on Remote Sensing and Geo-information Technology for Decision-makers, to be organized in co-operation with the Government of France and hosted by FAO in Rome from 23 May to 1 June 1990;

(b) United Nations/FAO International Training Course on Agricultural Applications of Remote Sensing, to be organized in co-operation with the Government of Czechoslovakia and hosted by the Agricultural University of Prague from 18 to 29 June 1990.

(d) Promotion of greater co-operation in space science and technology

33. The Sub-Committee noted that during the fortieth IAF Congress held at Málaga, Spain, from 7 to 13 October 1989, the United Nations had co-sponsored a special session on "Space and Flood Management" and supported the participation of three speakers from developing countries. It further noted that the United Nations Programme on Space Applications had co-operated with the American Institute for Aeronautics and Astronautics and the Space Institute of the University of Tennessee in organizing an International Symposium on Space Commercialization: Roles of Developing Countries, held at Nashville, Tennessee, from 5 to 10 March 1989 and supported the participation of three participants from developing countries; and had co-operated with the Sociedad de Especialistas Latinamericanos en Percepción Remota (SELPER) by supporting two participants from developing countries in the Fourth Latin American Symposium on Remote Sensing held at Bariloche, Argentina, from 24 to 28 November 1989.

34. The Sub-Committee also noted that the Programme planned to co-operate with COSPAR, IAF, the International Society for Photogrammetry and Remote Sensing (ISPRS) and SELPER in the organization of space-related meetings in 1990, 1991 and 1992 in order to promote greater co-operation between developing and developed countries and between developing countries. In particular, it noted that the Programme would be supporting the participation of specialists from developing countries in those meetings.

2. 1991

United Nations workshops/training courses/seminars/meetings of experts

35. The Sub-Committee recommended the approval of the programme of workshops/training courses/seminars/meetings of experts proposed for 1991, as outlined by the Expert in paragraph 32 of his report (A/AC.105/446), including the following:

(a) A United Nations workshop to be organized in co-operation with the ESCAP Regional Remote Sensing Programmme, FAO, and the Government of China on space technology applications to minimize and alleviate the impact of natural disasters, such as forest fires, floods, storms, high winds and earthquakes, to be held at Beijing in September 1991;

(b) The Sixteenth United Nations/FAO International Training Course on Remote Sensing Technology Applications, organized in co-operation with the Government of Italy;

(c) The Sixth United Nations/FAO/WMO/ESA Training Course on Remote Sensing Technology for Development, for the benefit of Member States in the ECLAC region;

(d) The Third United Nations Training Course on Communications Technology for Development, to be organized in co-operation with the Government of the USSR, with a possible postponement to 1992;

(e) The Third United Nations/FAO/ESA Workshop on Microwave Remote Sensing Technology, for the benefit of Member States in the ECA region;

(f) The Third United Nations Training Course on Remote Sensing Applications to Geological Sciences, to be organized in co-operation with the Government of the German Democratic Republic.

B. International space information service

36. The Sub-Committee noted with satisfaction that the Outer Space Affairs Division was in the process of developing a space information system including both information within the United Nations system and access to existing external data bases. Initial development work included information on space objects, space terminology and acronyms, and specialists in space technology and applications.

37. The Sub-Committee noted with satisfaction the publication of the document entitled "Seminars of the United Nations Programme on Space Applications: selected papers on remote sensing technology" (A/AC.105/443); the updated edition of the Directory on Education, Training, Research and Fellowship Opportunities in Space Science and Technology and its Applications (A/AC.105/432); and the addendum to the Directory of Information Systems on Space Science and Technology (A/AC.105/397/Rev.1/Add.1). The Sub-Committee also noted the preparation of a list of experts in space technology and applications, as recommended by the Working

Group of the Whole, and the plans to issue an integrated and updated Directory of Information Systems on Space Science and Technology.

## C. Reports

38. The Sub-Committee noted with appreciation the reports submitted to it in response to the recommendations of the Working Group of the Whole in its report on its third session (A/AC.105/429, annex II, paras. 4, 5 and 6).

## D. Co-ordination of space activities within the United Nations system and inter-agency co-operation

39. The Sub-Committee noted that the General Assembly, at its forty-fourth session, had reaffirmed its request that all organs, organizations and bodies of the United Nations system and other intergovernmental organizations working in the field of outer space or on space-related matters should co-operate in the implementation of the recommendations of UNISPACE 82.

40. The Sub-Committee noted with satisfaction that the eleventh Inter-Agency Meeting on Outer Space Activities had been convened by the Administrative Committee on Co-ordination (ACC) at Geneva and hosted by ITU from 27 to 29 September 1989, and that its report (ACC/1989/PG/8) was before the Sub-Committee. The Sub-Committee noted the information provided on the progress achieved in the co-ordination of space activities among organizations within the United Nations system and expressed its appreciation for the report of the Secretary-General entitled "Co-ordination of outer space activities within the United Nations system: programmes of work for 1990 and 1991 and future years" (A/AC.105/444).

41. The Sub-Committee was informed of a proposal to organize two workshops jointly by the Outer Space Affairs Division and the Centre for Science and Technology for Development, as the input to a publication on space technology and applications in the series of Advance Technology Alert Bulletins. It noted that the organization of the proposed workshops would be subject to the concurrence of concerned Governments and organizations as well as the availability of funds to be provided by the Centre. The Sub-Committee also noted the reservations expressed by some delegations concerning the organization of the workshops. In this connection, the Sub-Committee pointed out the role of the Committee on the Peaceful Uses of Outer Space and its subidiary bodies as the focal point for the co-ordination of space-related activities in the United Nations.

42. The Sub-Committee continued to stress the necessity of ensuring continuous and effective consultations and co-ordination in the field of outer space activities among organizations within the United Nations system and the avoidance of duplication of activities.

## E. Regional and interregional mechanisms of co-operation

43. The Sub-Committee noted that the General Assembly, in its resolution 44/46, had reaffirmed its approval of the recommendation of UNISPACE 82 regarding the establishment and strengthening of regional mechanisms of co-operation and their promotion and creation through the United Nations system. The Sub-Committee noted with satisfaction that, in carrying out various activities in the implementation of recommendations of UNISPACE 82, the Secretariat had sought to strengthen those mechanisms.

44. The Sub-Committee took particular note of the proposal for regional centres for education in space science and technology, based on existing national or regional educational institutions in developing countries, as outlined in paragraphs 33 to 37 of the report of the Expert (A/AC.105/446). The Sub-Committee urged Member States to consider providing voluntary contributions to support that effort.

45. The Sub-Committee noted the contributions made by other international organizations towards the promotion of international co-operation in outer space. In particular, it noted the work of ITU and its subsidiary bodies in the international co-ordination of radio communications, including satellite communications, in particular the planning of the 1992 World Administrative Radio Conference, which was of particular relevance to space matters, and the efforts of ITU in providing technical assistance to developing countries, including assistance in the development of a regional communication satellite system for Africa (RASCOM). The Sub-Committee also noted that INTELSAT was further developing its system for international satellite communications and that it was expanding its programme for training and education in the use of communication satellites for the benefit of developing countries, as part of the INTELSAT Assistance and Development Programme. The Sub-Committee also noted that ESA was continuing its programme of international co-operative space activities, including training programmes for the benefit of developing countries, support of the activities of the United Nations Programme on Space Applications and technical assistance projects organized in co-operation with the Asian Development Bank and the African Development Bank. The Sub-Committee also noted that INTERSPUTNIK was continuing to develop its communication satellite system and was expanding its programme of assistance to developing countries, through dissemination of information and assistance in Earth station development.

46. The Sub-Committee emphasized the importance of regional and international co-operation in making the benefits of space technology available to all countries, through such co-operative activities as shared payloads, dissemination of information on spin-off benefits, ensuring compatibility of space systems and providing access to launch capabilities at reasonable cost.

## III. MATTERS RELATING TO REMOTE SENSING OF THE EARTH BY SATELLITES, INCLUDING, INTER ALIA, APPLICATIONS FOR DEVELOPING COUNTRIES

47. In accordance with General Assembly resolution 44/46, the Sub-Committee continued its consideration of this item.

48. In the course of the debate, delegations reviewed the national and co-operative programmes in remote sensing. Examples were given of national programmes in developing and developed countries and of international programmes based on bilateral, regional and international co-operation, including programmes of technical co-operation between developing countries. Countries with advanced capabilities in the field, including some developing countries, described programmes to provide assistance to other developing countries.

49. The Sub-Committee noted the continuing programmes of China, France, India, Japan, the USSR and the United States for remote-sensing satellites as well as the planned remote-sensing satellite systems of Brazil, Canada and ESA. It also took note of the remote-sensing activities of FAO for mapping, assessment and management of renewable natural resources for the benefit of developing countries. In this connection, the Sub-Committee noted that special presentations had been given on remote sensing, as mentioned in paragraph 15 of the present report.

50. The Sub-Committee reiterated its view that remote sensing from outer space should be carried out, taking into account the need to provide appropriate and non-discriminatory assistance to meet the needs of the developing countries.

51. The Sub-Committee emphasized the importance of making remote-sensing data and analysed information available to all countries at reasonable cost and in a timely manner. The Sub-Committee also recognized the need for continuing free access to data from operational meteorological satellites.

52. The Sub-Committee felt that international co-operation in the use of remote-sensing satellites should be encouraged, both through co-ordination of the operations of ground stations and through regular meetings between satellite operators and users. It noted the importance of compatibility of data formats between different satellite systems. The Sub-Committee also noted the importance of the sharing of experiences and technologies between developing countries, through international and regional remote-sensing centres, and through joint work on collaborative projects.

53. The Sub-Committee noted the importance of satellite remote sensing for monitoring and protecting the Earth's environment, and in particular for studying and monitoring global climate change.

54. The Sub-Committee noted with satisfaction that 1990 would the the thirtieth anniversary of the launching of the first polar-orbiting weather satellite, which marked the beginning of international co-operation in global environmental monitoring from space.

55. Recalling General Assembly resolution 41/65 of 3 December 1986 by which the Assembly had adopted the Principles Relating to Remote Sensing of the Earth from Outer Space, the Sub-Committee recommended that at its twenty-eighth session it continue its discussion on remote sensing activities conducted in accordance with those principles, during its consideration of the agenda item concerning remote sensing.

56. The Sub-Committee recommended that the item be retained on its agenda as a priority item for the next session and that sufficient time be allocated for its consideration.

## IV. USE OF NUCLEAR POWER SOURCES IN OUTER SPACE

57. In accordance with General Assembly resolution 44/46, the Sub-Committee continued its consideration of this item and welcomed the additional amount of time allocated to its consideration.

58. In accordance with General Assembly resolution 44/46, the Working Group on the Use of Nuclear Power Sources in Outer Space was reconvened to resume its work at the current session. The Working Group met from 6 to 8 March 1990 under the chairmanship of Professor J. H. Carver (Australia). At a meeting held on 8 March 1990, the Working Group adopted its report (A/AC.105/C.1/L.168).

59. At its 385th meeting, on 9 March 1990, the Sub-Committee adopted the report of the Working Group, which is contained in annex III to the present report. With its current report, the Working Group has completed the elaboration of scientific and technical criteria for the safe use of nuclear power sources in outer space.

60. The Sub-Committee recommended that the item be retained on its agenda as a priority item for the next session. The Sub-Committee further recommended that the question of reconvening the Working Group on the Use of Nuclear Power Sources in Outer Space be considered by the Committee at its next session in the light of the work carried out by the Legal Sub-Committee on this subject at its twenty-ninth session.

## V. QUESTIONS RELATING TO SPACE TRANSPORTATION SYSTEMS AND THEIR IMPLICATIONS FOR FUTURE ACTIVITIES IN SPACE

61. In accordance with General Assembly resolution 44/46, the Sub-Committee continued its consideration of this item.

62. In the course of the discussion, delegations reviewed the national and co-operative programmes in space transportation systems. In particular, the Sub-Committee noted that:

(a) Brazil had continued its sounding rocket activities and, in 1990, had inaugurated the Launching Centre of Alcântara as part of a programme to develop a capability for complete space missions;

(b) China had launched an operational communications satellite into geostationary orbit and continued preparations for forthcoming launches of a commercial communications satellite, a meteorological satellite and a recoverable microgravity research satellite. It had also continued developmental work on new models of the Long March series of launchers;

(c) Iraq had conducted a successful test launch of its Al Abid rocket from the Al Anbar Space Centre;

(d) Japan had successfully launched a number of spacecraft during 1989, including the MUSES-A lunar probe to test technologies for use in further lunar and planetary exploration missions. The EXOS-D (Akebono) satellite had been launched to study auroral phenomena at altitudes from 300 to 8,000 kilometres. In the field of space applications, Japan had launched its fourth Geostationary Meteorological Satellite (GMS-4) and the second Marine Observation Satellite (MOS-1B), ensuring continuity of observations in those two programmes. As part of its development work on the H-II launch vehicle, Japan had conducted a test launch of the TR-1 rocket, a scale model of the H-II;

(e) In 1989, the USSR had continued its very active programme of space flights. The year had seen the end of one long-duration flight aboard the Mir space station by three cosmonauts, the beginning of a new mission by two other cosmonauts and the expansion of the station through the addition of a new module, Quant-2. Throughout the year, astrophysical, geophysical, technological, biological and medical experiments had been conducted aboard the station. Training for future missions had begun for cosmonauts from Austria, Japan and the United Kingdom. In the field of space-based astronomy, the Granat observatory had been launched and had begun making X-ray and gamma-ray observations. As part of the international co-operative Aktivny programme, the Intercosmos-24 satellite had been launched along with the Magion-2 sub-satellite for studying the Earth's magnetosphere. A biological satellite Cosmos-2044, in another co-operative effort, had carried experiments prepared in several countries. Further efforts had been made towards making Soviet launch vehicles available for use by other countries on a commercial basis;

(f) The United States had continued work on the development of the International Space Station Freedom, in co-operation with Canada, Japan and ESA. Five Space Shuttle flights had taken place in 1989, and development had continued on advanced booster rockets and on an extended-duration capability. The United States programme of planetary exploration had continued with the launch of the Magellan spacecraft to Venus and the Galileo spacecraft to Jupiter. The Voyager-2 spacecraft had produced important information during its fly-by of Neptune before continuing on into interstellar space. The Cosmic Background Explorer had been launched and had begun a programme of observations of radiation remaining from the early history of the universe. Work had advanced towards the launching in 1990 of the Hubble Space Telescope, a facility which would greatly extend the ability to observe the most distant objects in the universe. The United States had also continued its Landsat remote-sensing satellite programme and its programme of operational meteorological satellites. Almost all of these programmes had been undertaken with the co-operation of international partners;

(g) ESA had continued its programme of Ariane launches, placing into orbit its own satellites, national satellites of its member States and satellites for other countries and organizations. In addition to ESA's Olympus high-power communications satellite, Ariane had launched telecommunications satellites for Scandinavia (Tele-X), the Federal Republic of Germany (Kopernikus and TV-SAT), Japan (JCSAT-1 and Superbird A), and INTELSAT (Intelsat VA and VI). Ariane had also launched the Spot-2 remote-sensing satellite for France and the first operational Meteosat for the European Meteorological Satellite Organization (EUMETSAT), ensuring continuing data from those systems. In the field of space research, ESA had launched the Hipparcos satellite to make precise measurements of the positions of stars. ESA also had continued developmental work on the heavy launcher Ariane V, the space plane Hermes and the Columbus system, which included various elements provided by ESA as part of the international space station programme.

63. The Sub-Committee also noted the special presentation by a United States astronaut on the Space Shuttle mission that had launched the Magellan spacecraft to Venus, as mentioned in paragraph 15 of the present report.

64. The Sub-Committee noted the developments in various programmes related to space transportation and stressed the importance of international co-operation in the field in providing all countries with access to the benefits of space science and technology.

65. The Sub-Committee recommended that the item be retained on its agenda for the next session.

## VI. EXAMINATION OF THE PHYSICAL NATURE AND TECHNICAL ATTRIBUTES OF THE GEOSTATIONARY ORBIT; EXAMINATION OF ITS UTILIZATION AND APPLICATIONS, INCLUDING, INTER ALIA, IN THE FIELD OF SPACE COMMUNICATIONS, AS WELL AS OTHER QUESTIONS RELATING TO SPACE COMMUNICATIONS DEVELOPMENTS, TAKING PARTICULAR ACCOUNT OF THE NEEDS AND INTERESTS OF DEVELOPING COUNTRIES

66. In accordance with General Assembly resolution 44/46, the Sub-Committee continued consideration of this item.

67. In the course of the consideration of the item, some delegations expressed the view that the Sub-Committee should contribute to the efforts under way in the Legal Sub-Committee in the consideration of the issue of the geostationary orbit.

68. Some delegations expressed the view that it was important to continue the consideration of the question of the geostationary orbit taking into account its characteristics as a limited natural resource which required a special régime that guaranteed equitable access by all States, in particular by equatorial States. Other delegations expressed the view that this special régime which included equitable access should take into account primarily the needs of developing countries.

69. Some delegations noted that questions relating to the geostationary orbit were already being addressed effectively in ITU. They also reviewed recent developments in national and international space communications programmes, including technical developments that would contribute to ensuring that all countries would have access to satellite communications. Other delegations noted that, without ignoring the technical role and functions of ITU, the questions relating to the geostationary orbit were, in the global and political context, one of the principal responsibilities of the Committee on the Peaceful Uses of Outer Space and its sub-committees.

70. The Sub-Committee took note of the various current and planned satellite communications programmes of Member States and of international organizations such as INTELSAT and INTERSPUTNIK.

71. The Sub-Committee recommended that its consideration of the item be continued at its next session.

## VII. MATTERS RELATING TO LIFE SCIENCES, INCLUDING SPACE MEDICINE

72. In accordance with General Assembly resolution 44/46, the Sub-Committee continued its consideration of this item. The Sub-Committee heard special presentations on the question by experts from the USSR and the United States, as mentioned in paragraph 15 of the present report.

73. The Sub-Committee noted that studies of human physiology under conditions of manned space flight had led to important advances in medical knowledge in such areas as blood circulation, heart function and metabolism. It noted that products of space biotechnology, such as pharmaceuticals, could have a profound impact on health care on Earth and that telemedicine techniques developed for the treatment of astronauts during space flight were also applicable for improving health care in remote and disaster-stricken areas. The Sub-Committee took particular note of the successful Telemedicine Spacebridge, which had connected medical centres in the United States with Armenia and the town of Ufa in the USSR, following a severe earthquake in Armenia and a train accident in Ufa. The Telemedicine Spacebridge, conducted under the United States/USSR Joint Working Group on Space Biology and Medicine, had provided medical consultations for 210 patients, with others benefiting from the information transmitted.

74. The Sub-Committee noted that space studies in life sciences and medicine had important potential benefits for all countries and that efforts should be made to promote international co-operation to enable all countries to benefit from those advances.

75. The Sub-Committee recommended that its consideration of the item be continued at its next session.

## VIII. PROGRESS IN THE GEOSPHERE-BIOSPHERE (GLOBAL CHANGE) PROGRAMME

76. In accordance with General Assembly resolution 44/46, the Sub-Committee continued its consideration of this item.

77. The Sub-Committee noted with satisfaction that following its recommendation and that of the Committee, which had been endorsed by the General Assembly, COSPAR, at the invitation of the Sub-Committee, had made a special presentation to the Sub-Committee on progress in the international geosphere-biosphere (global change) programme, as mentioned in paragraph 14 of the present report. The Sub-Committee expressed its appreciation to COSPAR for its very informative presentation.

78. The Sub-Committee noted the progress being made through international co-operation in the planning of the international geosphere-biosphere (global change) programme for the 1990s. It noted that such a joint international effort was of fundamental importance for examining the future habitability of the planet and for managing the common natural resources of the Earth. The Sub-Committee took particular note of the need to involve as many nations as possible in the scientific activities of the programme, both in developed and in developing countries. It agreed that it should remain informed of progress in the programme so as to be able to facilitate international co-operation in that area.

79. In this connection, the Sub-Committee noted the proposal for an international environmental-monitoring space laboratory, possibly on the basis of the Almaz orbital stations, as described in document A/AC.105/C.1/L.165, and on the basis of the Priroda ecological module. The Sub-Committee also noted the capabilities of the planned Earth Observing System (EOS) for making comprehensive observations of the global environment. The Sub-Committee also noted the proposal for the Protection of the Environment for Assuring a Cleaner Earth (PEACE) satellite system. The Sub-Committee recommended that States consider participating in such co-operative activities.

80. The Sub-Committee recommended that its consideration of the item be continued at its next session.

## IX. MATTERS RELATING TO PLANETARY EXPLORATION

81. In accordance with General Assembly resolution 44/46, the Sub-Committee continued its consideration of this item. The Sub-Committee heard a special presentation on the question by an expert from the United States, as mentioned in paragraph 15 of the present report.

82. The Sub-Committee noted that in 1989, more than 12 years after its launch, the Voyager-2 spacecraft had flown by Neptune, thus completing its detailed observations of the four largest planets of the solar system. The Sub-Committee also noted that observations of Mars and its moon Phobos had been made by the Phobos-2 spacecraft, that the Magellan spacecraft had been launched towards Venus, where it would conduct a radar mapping programme, and that the Galileo spacecraft

had been launched on a complex trajectory to Jupiter, where it would make detailed observations of that planet. The Sub-Committee also took note of the plans for future spacecraft to conduct comprehensive investigations of Mars, to observe the polar regions of the Sun and to investigate the Saturn system. It noted in particular the high degree of international co-operation in all of those investigations.

83. The Sub-Committee recommended that its consideration of the item be continued at its next session.

## X. MATTERS RELATING TO ASTRONOMY

84. In accordance with General Assembly resolution 44/46, the Sub-Committee continued its consideration of this item. The Sub-Committee heard a special presentation on the question by an expert from the United States, as mentioned in paragraph 15 of the present report.

85. The Sub-Committee noted that the use of spacecraft for making astronomical observations from above the atmosphere had greatly advanced knowledge of the universe by allowing observations in all regions of the electromagnetic spectrum. It noted that with the launchings of Hipparcos, the Cosmic Background Explorer (COBE) and the Granat spacecraft astronomers had powerful new tools for their investigations of the universe. The forthcoming launches of the Hubble Space Telescope, the Gamma Ray Observatory, Rosat and the Gamma-1 observatory would open up further realms of the universe to detailed observation. The Sub-Committee noted with satisfaction that all of those projects were open to broad international co-operation.

86. The Sub-Committee recommended that its consideration of the item be continued at its next session.

## XI. THEME FIXED FOR SPECIAL ATTENTION AT THE 1990 SESSION: "THE USE OF SPACE TECHNOLOGY IN TERRESTRIAL SEARCH AND RESCUE AND IN DISASTER RELIEF ACTIVITIES"

87. In accordance with General Assembly resolution 44/46, the Sub-Committee paid special attention to the theme "The use of space technology in terrestrial search and rescue and in disaster relief activities". The Sub-Committee noted with satisfaction that, following its recommendation and that of the Committee and in accordance with resolution 44/46, COSPAR and IAF had, at the invitation of the Sub-Committee, conducted a symposium on the theme on 27 and 28 February 1990. The Sub-Committee expressed appreciation to COSPAR and IAF for the very instructive symposium.

88. The Sub-Committee noted with satisfaction the highly successful international project for satellite-aided search and rescue known as COSPAS-SARSAT. In that connection, the Sub-Committee recommended that all Member States and relevant

international organizations consider utilizing to the maximum extent possible the COSPAS-SARSAT system for global search and rescue activities.

89. The Sub-Committee noted that the General Assembly had designated the 1990s as the International Decade for Natural Disaster Reduction and that the Office of the United Nations Disaster Relief Co-ordinator (UNDRO) had been designated as the focal point for activities aimed at reducing the devastating effects of catastrophic natural disasters.

90. The Sub-Committee noted the important role that space technology could play in reducing the effects of such disasters as severe storms, floods, landslides, droughts, locust swarms, volcanic eruptions, earthquakes and disasters at sea. It also noted the role of international organizations and agencies such as the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), WMO and INMARSAT in that field.

## XII. OTHER MATTERS

### A. International Space Year - 1992

91. The Sub-Committee noted that the General Assembly, in its resolution 44/46, paragraph 20, had endorsed the initiative of international scientific organizations and bodies to designate 1992 as International Space Year (ISY). It also noted that the General Assembly, in paragraph 21 of the same resolution, had endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space that international co-operation should be promoted through the International Space Year, which should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries, and that, in that context, the training and educational capabilities of the United Nations Programme on Space Applications should be utilized to bring about a meaningful role for the United Nations, through voluntary contributions and without any impact on the regular budget of the United Nations or the existing programme of work of the Programme.

92. The Sub-Committee had before it a proposed programme for the participation of the United Nations in International Space Year, to be celebrated in 1992 (A/AC.105/445 and Add.1 and 2). The Sub-Committee noted that 1992 would also be the tenth anniversary of UNISPACE 82. The Sub-Committee urged other Member States and international organizations to consider supporting additional scientific and technical activities in co-operation with the United Nations as part of International Space Year. The Sub-Committee noted that it was particularly important to increase voluntary contributions for ISY activities to be carried out through the United Nations Programme on Space Applications, since the Programme was dependent on voluntary contributions for most of its activities.

93. The Sub-Committee considered that the activities to be undertaken by the United Nations and the specialized agencies as part of ISY should be complementary to the activities of international organizations such as COSPAR, IAF and the Space Agency Forum for International Space Year.

94. The Sub-Committee noted the primary focus of proposed ISY activities on the use of space technology for studying and monitoring the environment. It noted that the United Nations Conference on Environment and Development was also being planned for 1992 and recommended that Member States, in planning their activities for ISY, consider ways in which those activities could complement the efforts under way for the Conference on Environment and Development.

95. The Sub-Committee noted the various national and international programmes being proposed as part of International Space Year. It noted the importance of including all countries in those programmes and of planning activities that would continue beyond 1992.

96. The Sub-Committee requested the Secretariat to keep the Committee and the Sub-Committee informed of further developments relating to this question.

## B. Space and Earth environment

97. The Sub-Committee also noted that the General Assembly, in paragraph 22 of resolution 44/46, had recommended that more attention be paid to all aspects related to the protection and preservation of the outer space environment, especially those potentially affecting the Earth's environment.

98. The Sub-Committee noted further that the General Assembly, in paragraph 23 of resolution 44/46, had considered that it was essential that Member States pay more attention to the problem of collisions with space debris, and other aspects of space debris, and called for the continuation of national research on that question. The Sub-Committee took note of the studies relating to space debris that had been carried out by Member States.

99. Some delegations expressed the view that the fact that outer space was progressively becoming an integral part of the human environment gave an increased sense of urgency to the proper treatment of the questions relating to the threats posed by space activities to the Earth environment and to the preservation of the space environment itself. Those delegations further expressed the view that the essential question to be addressed was that of avoiding the uncritical transfer to outer space of the patterns of use of resources that prevailed on Earth.

100. Some delegations expressed the view that increased knowledge regarding the space environment was necessary to control the amount of space debris, and that compilation of and access to data on space debris and the tracking and monitoring of the space debris environment could not be done effectively without international co-operation.

101. Some delegations expressed the view that the question of space debris should be included on the Sub-Committee's agenda, allowing for a general exchange of views and information. Other delegations, while recognizing the importance of the subject, expressed the view that such consideration was premature until further national research on the problem of space debris had been completed.

## C. Other reports

102. The Sub-Committee welcomed the report of WMO on its Tropical Cyclone Programme for 1988/89 (A/AC.105/447); the annual report of ESA for 1988 (A/AC.105/435); the annual report of INTELSAT for 1988/89 (A/AC.105/455); as well as the advance copies of the annual report of INTERCOSMOS for 1989 and the twenty-ninth report of ITU on telecommunication and the peaceful uses of outer space, which will be submitted to the thirty-third session of the Committee, to be held in June 1990. The Sub-Committee requested ITU, WMO, ESA, INTELSAT and INTERCOSMOS to continue to report on their work.

103. The Sub-Committee expressed its appreciation to COSPAR for its report on the progress of space research during the period 1988-1989 (A/AC.105/452) and to IAF for its report on highlights of space technology during 1989 (A/AC.105/453).

104. The Sub-Committee noted with appreciation the participation in its session of representatives from United Nations bodies, specialized agencies and permanent observers, and found the reports/statements they had made helpful in enabling the Sub-Committee to fulfil its role as focal point for international co-operation.

## D. Review of the future role and work of the Scientific and Technical Sub-Committee

105. The Sub-Committee recommended that the agenda of its twenty-eighth session include the following priority items:

(a) Consideration of the United Nations Programme on Space Applications and the co-ordination of space activities within the United Nations system;

(b) Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82);

(c) Matters relating to remote sensing of the Earth by satellites including, inter alia, applications for developing countries;

(d) The use of nuclear power sources in outer space.

106. The Sub-Committee also recommended that the agenda of the twenty-eighth session include the following items:

(a) Questions relating to space transportation systems and their implications for future activities in space;

(b) Examination of the physical nature and technical attributes of the geostationary orbit; examination of its utilization and applications, including, inter alia, in the field of space communications, as well as other questions relating to space communications developments, taking particular account of the needs and interests of developing countries;

(c) Matters relating to life sciences, including space medicine;

(d) Progress in national and international space activities related to the Earth environment, in particular progress in the geosphere-biosphere (global change) programme;

(e) Matters relating to planetary exploration;

(f) Matters relating to astronomy;

(g) The theme fixed for special attention at the 1991 session of the Scientific and Technical Sub-Committee: "Applications of airborne and satellite remote sensing for prospecting mineral and ground-water resources and for monitoring and managing biological resources, with emphasis on agriculture, taking into particular account the needs of developing countries".

107. The Sub-Committee recommended that, regarding agenda item (d) in paragraph 106 above, COSPAR and IAF should be invited to present reports and arrange a special presentation on progress in the geosphere-biosphere (global change) programme. The Sub-Committee further recommended that, regarding agenda item (g) in paragraph 15 above, COSPAR and IAF should be invited to arrange a symposium with as wide a participation as possible, to be held during the first week of the Sub-Committee's session, to complement discussions within the Sub-Committee on the theme "Applications of airborne and satellite remote sensing for prospecting mineral and ground-water resources and for monitoring and managing biological resources, with emphasis on agriculture, taking into particular account the needs of developing countries".

108. The Sub-Committee recommended that the title of agenda item (d) in paragraph 106 above, previously entitled "Progress in the geosphere-biosphere (global change) programme", should be changed to "Progress in national and international space activities related to the Earth environment, in particular progress in the geosphere-biosphere (global change) programme".

109. The Sub-Committee, noting the significant progress that had been achieved in its consideration of the item on the use of nuclear power sources in outer space, recommended that the Committee, at its next session, should consider the future work of the Sub-Committee and the ways in which it affects the work of the Legal Sub-Committee, in particular on the agenda item on nuclear power sources in outer space.

110. Some delegations expressed the view that the unique role of the Sub-Committee as an intergovernmental forum should be strengthened. Those delegations further expressed the view that the task of the Sub-Committee was to discuss policies and guidelines for international co-operation in space activities and to provide agreed technical parameters in order to help the development of the international regulation of the peaceful uses of outer space.

111. Some delegations, while recognizing the significance of the scientific and technical presentations to the Sub-Committee, expressed the view that the presentations should not interfere with the substantive work of the Sub-Committee, which should have priority over such presentations.

112. The Sub-Committee took note of the statement of the Chairman of the Group of 77 that Mr. Raimundo González (Chile), the Chairman of the Working Group of the Whole to evaluate the implementation of the recommendations of UNISPACE 82, had been nominated as candidate for Chairman of the Legal Sub-Committee's Working Group on the new agenda item, and that the Group of 77 would nominate Mr. Muhammad Nasim Shah (Pakistan) as candidate for the new Chairman of the Working Group of the Whole. The Sub-Committee expressed its appreciation to Mr. González for his work as Chairman of the Working Group.

## XIII. TRIBUTE

113. The Members of the Sub-Committee expressed their sincere congratulations and their deep gratitude to Professor John H. Carver upon his completion of 20 years as Chairman for his dedicated service to and leadership of the Sub-Committee. During that long period of time, his devotion to the work of the Sub-Committee had been an important factor in its achievements in the promotion of international co-operation in the peaceful uses of outer space.

## Annex I

## DOCUMENTS BEFORE THE SCIENTIFIC AND TECHNICAL SUB-COMMITTEE AT ITS TWENTY-SEVENTH SESSION

Item 1 - Adoption of the agenda

| | |
|---|---|
| A/AC.105/C.1/L.163 | Provisional agenda, with annotations, for the twenty-seventh session |

Item 4 - United Nations Programme on Space Applications and the co-ordination of space activities within the United Nations system

Item 5 - Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space

| | |
|---|---|
| A/44/324 and Add.1-5 | Comprehensive policy review of operational activities of the United Nations system: note by the Secretary-General |
| A/44/16 | Report of the Committee for Programme and Co-ordination |
| A/RES/44/194 | Programme planning |
| A/AC.105/436 | Report on the United Nations/FAO/ESA Meeting of Experts on Remote Sensing and Satellite Meteorology Applications to Marine Resources and Coastal Management in the Atlantic Coast of Africa Region, organized in co-operation with the Government of Spain and hosted by the Instituto Nacional de Tecnica Aerospacial, Gran Canaria, Spain, May 1989 |
| A/AC.105/437 | Report on the Fifth United Nations/FAO/WMO/ESA Training Course on the Use of Remote Sensor Systems in Agrometeorological and Hydrological Applications, co-sponsored by the Government of Australia and the Economic and Social Commission for Asia and the Pacific, Canberra, May/June 1989 |
| A/AC.105/438 | Report on the United Nations International Meeting of Experts on the Development of Remote Sensing Skills and Knowledge, organized in co-operation with the Government of the United Kingdom of Great Britain and Northern Ireland and hosted by the University of Dundee, Dundee, June 1989 |

| | |
|---|---|
| A/AC.105/439 | Report on the United Nations/Indian Ocean Marine Affairs Co-operation Conference Workshop on Oceanographic/Marine Space Information Systems, co-sponsored and hosted by the Government of Pakistan, Karachi, July 1989 |
| A/AC.105/440 | Report on the United Nations International Training Course on the Use of Remote Sensing Data in Agriculture Management, held in co-operation with the Government of the Union of Soviet Socialist Republics, Moscow, September/October 1989 |
| A/AC.105/441 | Report on the Second United Nations International Training Course on Remote-Sensing Applications to Geological Sciences, hosted and co-sponsored by the Government of the German Democratic Republic, Potsdam, October 1989 |
| A/AC.105/442 | Report on the Fourteenth United Nations/FAO International Training Course on the Applications of Remote Sensing to Land Resources, held in co-operation with the Government of Italy, Rome, November 1989 |
| A/AC.105/443 | Seminars of the United Nations Programme on Space Applications |
| A/AC.105/444 and Corr.1 | Co-ordination of outer space activities within the United Nations system: programmes of work for 1990 and 1991 and future years |
| A/AC.105/446 | Report of the United Nations Expert on Space Applications to the Scientific and Technical Sub-Committee, February/March 1990 |
| ACC/1989/PG/8 | Report of the Ad Hoc Inter-Agency Meeting on Outer Space Activities, held at the International Telecommunication Union headquarters, Geneva, 27-29 September 1989 |

Item 7 - Use of nuclear power sources in outer space

| | |
|---|---|
| A/AC.105/C.1/WG.5/L.24 and Add.1-3 and L.24/Add.2/Corr.1 | Information/working papers submitted by Governments |
| A/AC.105/C.1/WG.5/L.25 | Safety aspects of nuclear power sources in outer space: study submitted by the Federal Republic of Germany |

| | |
|---|---|
| A/AC.105/C.1/WG.5/L.26 | Problem of the early warning of the re-entry of a satellite with a nuclear power source on board: working paper submitted by Canada |
| A/AC.105/C.1/WG.5/L.27 | Safety aspects and recommendations for the use of nuclear power sources in outer space: working paper submitted by the Federal Republic of Germany |
| A/AC.105/C.1/L.168 | Report of the Working Group on the Use of Nuclear Power Sources in Outer Space on the work of its eighth session |
| A/AC.105/C.1/WG.5/INF/1 | List of experts |

Item 11 - Progress in the geosphere-biosphere (global change) programme

| | |
|---|---|
| A/AC.105/C.1/L.165 | Progress in the geosphere-biosphere (global change) programme: working paper submitted by the Union of Soviet Socialist Republics |

Item 15 - Other matters:

(a) Other reports

(b) Review of the future role and work of the Scientific and Technical Sub-Committee

| | |
|---|---|
| A/AC.105/445 and Add.1-2 | Participation of the United Nations in International Space Year: note by the Secretariat |
| A/AC.105/C.1/L.164 | Information on activities being planned in the USSR in connection with International Space Year |
| A/AC.105/447 | WMO Tropical Cyclone Programme: report by the World Meteorological Organization |
| A/AC.105/452 | Progress of space research 1988-1989: report submitted by the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU) |
| A/AC.105/453 | Highlights in space technology and applicacions of 1989: report submitted by the International Astronautical Federation (IAF) |
| A/AC.105/455 | Report of the International Telecommunications Satellite Organization (INTELSAT) |

Working Group of the Whole to Evaluate the Implementation of the Recommendations of UNISPACE 82

| | |
|---|---|
| A/44/469 | Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82): report of the Secretary-General |
| A/AC.105/428/Add.1 | Review of national and international space activities for the calendar year 1988: Information provided by the United States of America |
| A/AC.105/448/Add.1-3 | International co-operation in the peaceful uses of outer space - programmes of Member States |
| A/AC.105/449 | International co-operation in the peaceful uses of outer space - programmes of international space organizations |
| A/AC.105/450 | Regional and international education, training and research centres in space science and technology and its applications: report by the Secretariat |
| A/AC.105/451 | Implementation of the recommendations of the UNISPACE 82 Conference: report by the Secretariat in response to the request of the Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space |
| A/AC.105/454 | United Nations activities relating to space applications: report of the Secretariat in response to the request of the Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space |
| A/AC.105/C.1/L.167 | Report of the Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space on the work of its fourth session |

## Annex II

## REPORT OF THE WORKING GROUP OF THE WHOLE TO EVALUATE THE IMPLEMENTATION OF THE RECOMMENDATIONS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE ON THE WORK OF ITS FOURTH SESSION

1. The Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), re-established for its fourth session by the Scientific and Technical Sub-Committee in accordance with paragraph 10 of General Assembly resolution 44/46 of 8 December 1989, with a view to improving the execution of activities relating to international co-operation, particularly those included in the United Nations Programme on Space Applications, and to propose concrete steps to increase such co-operation as well as to make it more efficient, held a series of meetings at United Nations Headquarters between 27 February and 6 March 1989.

2. Mr. Raimundo González (Chile) was elected Chairman of the Working Group. The Chairman, in his opening statement, examined the mandate of the Working Group at its fourth session and the status of the implementation of the recommendations of UNISPACE 82.

3. In considering the item, the Working Group had before it the studies and reports prepared by the Secretariat and international organizations as requested by the Working Group at its third session and endorsed by the General Assembly in paragraph 11 of resolution 44/46. The Working Group also had before it a proposal of the Group of 77, contained in document A/AC.105/C.1/WG.6/L.4.

4. Since many of the recommendations contained in the report of UNISPACE 82 have still not been fully implemented, the Working Group proposed that the following should be undertaken, bearing in mind the priorities contained in paragraph 9 of General Assembly resolution 44/46:

(a) The emphasis of the United Nations Programme on Space Applications should remain on long-term, project-oriented on-the-job training in space technology itself as well as its specific application areas, in particular, new developments in satellite systems, software for remote sensing and use of digital processing systems and training for management of ground stations. The Working Group noted with appreciation the offers made by some Member States and international organizations in that regard and urged other Member States and international organizations to make similar contributions so that the number of fellowships offered for the Programme year 1990 and subsequent years could be increased. The Outer Space Affairs Division of the United Nations Secretariat should make every effort to arrange for the increase in the number of fellowships offered and to encourage full utilization of the fellowships. In that regard, the Outer Space Affairs Division should make every effort to devote as much as possible of the resources allocated to it to the implementation of the Programme on Space Applications. In order to facilitate the development by the developing countries

of their indigenous research and development capabilities, the number of trainees from each country should be sufficient to create a national core group of experts.

(b) Regarding the United Nations workshops/training courses/seminars/meetings of experts, the Working Group noted with appreciation that several activities had been proposed for the years 1990 and 1991 in the report of the Expert on Space Applications (A/AC.105/446). The Working Group recommended that those activities should be implemented.

(c) In the light of the continued development and evolution of space activities, the Committee should request all States, particularly those with major space or space-related capabilities, to inform the Secretary-General annually, as appropriate, about those space activities that were or could be the subject of greater international co-operation, with particular emphasis on the needs of the developing countries, in order to permit a better assessment of the present and future of such international co-operation by the Working Group at its next session.

(d) Similarly, the Committee should also request international organizations with space-related activities to inform the Secretary-General annually concerning those space activities that were or could be the subject of greater international co-operation, with particular emphasis on the needs of the developing countries, in order to permit a better assessment of the present and future of such international co-operation by the Working Group at its next session.

(e) In order to promote better access to and experiences in higher education in space-related subjects, the United Nations should, upon request, arrange for the provision of consultancy in the form of experts from the developed and developing countries in the preparation of an integrated national plan of action for initiating, strengthening or reorienting an appropriate space applications programme which should be in conformity with other national development programmes. Based on such requests, the Outer Space Affairs Division should compile a list of experts in space technology and applications, in consultation with Member States and their national space authorities, to facilitate the exchange of consultants at the international level. The list should be updated periodically and circulated among the Member States for their information.

(f) In formulating co-operative programmes and projects, intensive participation of international and regional financial and development institutions should be encouraged by the United Nations. In this connection, the Secretariat should prepare annually a report on the arrangements it has made with other organs, bodies and organizations of the United Nations system in order to utilize fully the available resources and to secure additional financial support from other sources for continued implementation of the United Nations Programme on Space Applications.

(g) Extensive co-operation should be encouraged among countries within a region through sharing their human resources, technical expertise, hardware and software for the space-related projects. If a country or countries within a region find it beyond their resources to undertake a programme by themselves, the United Nations should, upon request, endeavour to co-ordinate with them towards establishing a regional programme addressing the needs of those countries.

(h) In order to promote and co-ordinate the exchange of information on results of scientific discoveries, greater interaction should be encouraged among application specialists and experimental and theoretical scientists with a view to promoting wider application of the results of scientific research.

(i) Encouragement should be given to non-governmental organizations which, by means of conferences, publications and other activities including the holding of symposia and meetings devoted to special topics, could help to integrate regional and interregional efforts in order to facilitate and co-ordinate the space activities of scientific organizations. The United Nations should strengthen its co-operation with them, as part of its commitment to assisting developing countries attain the benefits of space technology. Efforts should also be made by the United Nations to seek the co-operation of other international and regional bodies specialized in space activities.

(j) On the basis of the information provided by the States, the Division should prepare on a regular basis an updated report on the resources and technological capabilities of the States in the fields of space activities for the promotion of co-operation in the peaceful uses of outer space. Similarly, the Division should prepare on a regular basis an updated report on the capabilities of States in the areas of education, training, research and fellowship opportunities, for the promotion of co-operation in the peaceful uses of outer space.

(k) Countries with relevant capabilities are once again encouraged to provide to the developing countries financial and technical assistance for developing low-cost community receivers for communication satellites and low-cost, preferably renewable, power sources to operate the systems in unelectrified locations.

(l) Given the investments already made on the ground by many countries in the form of ground stations, processing equipment, data banks, software, etc., for remote-sensing data reception/analysis, satellite-operating States are urged to ensure the availability of data on a continued basis and in a form compatible with the current systems.

(m) The Working Group requested the Outer Space Affairs Division to prepare a report on the economic aspects of the implementation of the recommendation contained in paragraph 9 (b) of General Assembly resolution 44/46, on the basis of information provided by Member States and the reports of the United Nations meetings that have been held on the subject, so that at its next session the Working Group could examine in detail the most cost-effective and efficient ways of implementing the recommendation.

(n) Taking into account paragraph 9 (c) of General Assembly resolution 44/46, the United Nations should lead, with the active support of its specialized agencies and other international organizations, an international effort to establish regional centres for space science and technology education in existing national/regional educational institutions in the developing countries.

5. The Working Group took note, with appreciation, of the report contained in document A/AC.105/451 and requests the Secretariat to update its report for the

information of the subsequent sessions of the Scientific and Technical Sub-Committee. Noting that some of the space applications studies recommended by UNISPACE 82 were incomplete and some of them were limited in scope, the Working Group proposed that:

(a) In the case of priority studies recommended by UNISPACE 82, information from different reports should be integrated and new information should be compiled in order to provide Member States with comprehensive studies;

(b) Based upon the results obtained in implementation of subparagraph (a) above, a few specific studies should be carried out to demonstrate the potentials of space technology, which might include the following:

(i) Integrated land and water resources management for rural development;

(ii) Remote and rural area communications and broadcasting;

(iii) Forest resources management;

(iv) Flood monitoring and control;

(v) Desertification;

(vi) Ocean resources development;

(vii) Upper atmosphere studies for weather and environment monitoring.

As a first step, information on some of those subjects might be provided as part of the United Nations efforts in conjunction with International Space Year.

6. In order to permit a better assessment of the implementation of the recommendations of UNISPACE 82, the Working Group recommended that, as a first step, the following reports be prepared:

(a) A report dealing with the implementation of the recommendations of UNISPACE 82 addressed to specialized agencies and other international organizations, as listed in annexes I and II of A/AC.105/451, on the basis of information provided by those agencies and organizations;

(b) A report dealing with the implementation of the priority recommendations of UNISPACE 82 addressed to Member States, as identified in paragraph 9 of General Assembly resolution 44/46, on the basis of information provided by them.

7. The Working Group recommended that it should be reconvened next year to continue its work.

Annex III

REPORT OF THE WORKING GROUP ON THE USE OF NUCLEAR POWER SOURCES IN OUTER SPACE ON THE WORK OF ITS EIGHTH SESSION

I

1. The Working Group on the Use of Nuclear Power Sources in Outer Space, reconvened in accordance with General Assembly resolution 44/46 of 8 December 1989, paragraph 12, held its eighth session at United Nations Headquarters from 5 to 8 March 1990. Mr. J. H. Carver (Australia) served as its Chairman.

2. The Working Group held five meetings. A list of the experts attending the session is given in document A/AC.105/C.1/WG.5/INF/1.

3. The Working Group had before it replies from Austria, Czechoslovakia, Finland, the Federal Republic of Germany, Japan, Pakistan, Sweden, United Arab Emirates and the Union of Soviet Socialist Republics, to the Secretary-General's note verbale dated 30 June 1989 (A/AC.105/C.1/WG.5/L.24, Add.1-3 and Add.2/Corr.1) as well as working papers and studies submitted by Canada (A/AC.105/C.1/WG.5/L.26) and the Federal Republic of Germany (A/AC.105/C.1/WG.5/L.25 and 27).

4. Following an exchange of views, the Working Group adopted the present report at the conclusion of its meeting on 8 March 1990.

II

5. The Working Group reviewed the conclusions it had reached in its previous reports, in particular, that of its third session (A/AC.105/287, annex II).

6. The Working Group noted that countries launching nuclear power sources (NPS) should conduct safety assessments of those systems and should make those assessments publicly available. In particular, the Working Group took note of the oral statement on the safety assessment process for the Galileo interplanetary mission as described by the United States of America.

7. Some delegations stated that since there was a reasonably high probability of collision of spacecraft carrying NPS with space debris in the altitude band of 800 to 1,000 kilometres, it was essential to study the question and to develop methods to minimize possible radiological hazards. This might require the development of new technologies for prevention of the creation of new debris, monitoring of the situation or even removal of space debris from orbit.

8. The view was expressed that the consequences of a spacecraft with NPS on board colliding with space debris could be studied using a variety of collision models. The risk of collisions should be studied particularly in the altitude range of 800 to 1,100 kilometres, where most nuclear sources, together with a large number of other satellites and the maximum density of space debris, were to be found. Since different types of objects could collide, methods had to be developed for calculating the effects of elastic and non-elastic impacts, and of spacecraft

destruction with the scattering of secondary fragments. Numerical computation could reveal changes in the orbital lifetimes of the resulting objects and their interaction with the atmosphere.

9. Some delegations emphasized that space missions with NPS should be justified by the radiation protection criteria recommended by the International Commission on Radiological Protection (ICRP) in terms of benefit versus risk. The view was expressed that the results of that justification procedure should be made publicly available.

10. Some delegations were of the view that if there was a need for guidance relating to quantitative dose limits, the international organizations dealing with radiological health questions in general, in the first place the International Atomic Energy Agency (IAEA), should be the proper bodies to develop such advice.

11. Other delegations were of the view that the ICRP recommendations were especially important in the work to develop NPS safety principles and also recalled the mandate provided to the Committee on the Peaceful Uses of Outer Space and its sub-committees to develop such principles.

12. It was observed that there was not an urgent need to seek quantitative limitations to the amount of radioactive material either in individual nuclear devices or in the total radioactive inventory in orbit, as long as the number of space missions employing NPS was small and the nuclear devices had a radioactivity content similar to that currently used.

13. The Working Group noted with appreciation the above-mentioned papers submitted by Canada, the Federal Republic of Germany and the Union of Soviet Socialist Republics (A/AC.105/C.1/WG.5/L.24/Add.2, and L.25-27).

14. During the consideration of document A/AC.105/C.1/WG.5/L.27, a presentation was made of the provisions contained in document A/AC.105/C.2/L.173, and a proposal was made that principle 3 as contained in that document be supplemented to the effect that, as soon as technology permitted, any State launching a space object with a nuclear power source on board should include, as part of the component of the space object containing the NPS, an impact position indicator that would, for example, transmit electronic signals to facilitate location of the impact point with a high degree of accuracy, and provide time of impact on the Earth's surface, identify the launching State and the space object in question.

## III

15. The Working Group agreed on the following recommendations for the safe use of nuclear power sources in outer space:

> In order to minimize the quantity of radioactive material in space and risks involved, the use of nuclear power sources in outer space should be restricted to those space missions which cannot be operated by non-nuclear energy sources in a reasonable way.

1. Design goals for radiation protection

1.1 The general radiation safety objective for NPS in space is to protect individuals, population as a whole and the biosphere against radiological hazards. Therefore, the design of NPS should ensure, with a high degree of confidence, that the hazards - in all foreseeable circumstances, operational or accidental - are kept below an acceptable level.

The design of NPS should also ensure with high reliability that radioactive material does not significantly pollute outer space.

1.2 During normal operation of NPS, including re-entry from the sufficiently high orbit (SHO),* the appropriate radiation protection objective for the public recommended by the International Commission on Radiological Protection (ICRP) should be observed. It is recommended that during such normal operation there should be no significant radiological exposure.

1.3 To limit exposures in accident scenarios, the design of the NPS safety system should take into account relevant international guidelines recommended by the International Commission on Radiological Protection.

The design goal for the NPS safety system should be with a high degree of confidence a regional limitation of radiation exposure and a limitation of the individual dose to the principal limit of 1 mSv in a year. However, it is permissible to use a subsidiary dose limit of 5 mSv in a year for some years, provided that the average annual effective dose equivalent over a lifetime does not exceed the principal limit of 1 mSv in a year. Future modifications of the recommendations of ICRP should be applied.

The NPS safety system should also ensure that the probability of serious radiological consequences is extremely small.

1.4 The important safety systems shall be designed, constructed and operated in accordance with the general concept of defence-in-depth, which refers, for example, to the successive barriers containing radioactive materials of the NPS.

Pursuant to this concept, any foreseeable failure or malfunction of a device that is important for safety must be capable of being corrected or counteracted by another device or by another action, possibly automatic.

The reliability of important safety systems shall be ensured, inter alia, by redundancy, physical separation, functional isolation and adequate independence of their components.

Other measures should also be taken to raise the level of safety.

---

* As defined in subparagraph 2.1.

1.5 For NPS re-entries into the Earth's atmosphere, which may occur after a malfunction in orbital operations, the launching State should provide technical support to identify the location of re-entry and impact, to detect the re-entered radioactive material and, on request, to carry out retrieval or clean-up operations.

2. Nuclear reactors

2.1 Considering the risk of re-entry, nuclear reactors are acceptable for operation on interplanetary missions or in sufficiently high orbits (SHO). The SHO is one in which the orbital lifetime is long enough to allow for a sufficient decay of the fission products to about the activity of the actinides. The SHO must be such that the risks to existing and future outer space missions and of collision with other space objects are kept to a minimum. In determining SHO altitude it should be taken into consideration that, in case of destruction of the reactor, the reactor parts should also attain the necessary level of reduction in radioactivity before they re-enter the Earth's atmosphere.

2.2 If nuclear reactors are used in low Earth orbits, they should be stored, after their mission, in an SHO.

2.3 Nuclear reactors should only use highly enriched uranium 235 as fuel. The design should consider the radiological decay of the fission and activation products.

2.4 The design and the construction of the nuclear reactor should ensure that it cannot become critical before reaching the operating orbit, during all possible events such as rocket explosion, re-entry, impact on ground or water or submersion in water.

2.5 Nuclear reactors should not be made critical before they have reached their operating orbit or interplanetary trajectory.

2.6 In view of possible failures in the NPS systems or of satellites during operations in orbit (including operation for transfer into the SHO), there should be a highly reliable operational system to ensure effective and controllable disposal of the reactor. Such measures could be, for example, reserve elements of the systems for reaching the SHO, or other methods to be developed in the future.

3. Isotope generators

3.1 Isotope generators should preferably be used for interplanetary missions and other missions leaving the gravity field of the Earth. They may also be used in Earth orbits if they are stored after mission end in a high orbit. Ultimate disposal would, however, still be required.

3.2 Isotope generators should be protected by a containment system which withstands the heat and the aerodynamic forces during the re-entry in the upper atmosphere under all possible orbital conditions, i.e., also from highly elliptical or hyperbolic orbits if relevant. Upon ground impact, the containment system and the physical form of the isotope should ensure that no radioactive material is scattered (in soluble, volatile, aerosol or micro-particle form) into the environment so that the impact area can be completely cleared of radioactivity by a recovery operation.

16. The Working Group agreed that representatives of States concerned could, in accordance with the work completed to date by the Working Group, conduct consultations with IAEA on the question of elaborating recommendations concerning the organization and conduct of operations for emergency planning and preparedness in case of accidental re-entry of NPS into the Earth's atmosphere.

---